REFERENCE SAMPLE PROGRAM

METHOD OF TEST FOR
COARSE AGGREGATE GRADATION

2017 PROFICIENCY TEST RESULTS

State of California Department of Transportation
Office of Roadway Materials Testing
Materials Engineering and Testing Services
Division of Engineering Services
5900 Folsom Blvd, MS #5
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March 1, 2017

TABLE OF CONTENTS

LIST OF TABLES

Appendix A – Test Results from Initial Test

Appendix B – Test Results from Retest

Appendix C – Test Results from Witness Test

REFERENCE SAMPLE PROGRAM

CORASE AGGREGATE GRADATION

2017 PROFICIENCY TEST RESULTS

1.0   OVERVIEW

In early March 2016, announcements for the proficiency testing of coarse aggregate gradation was opened for laboratory participation. This proficiency test was based on the California Test 202, "Method of Test for Determining Sieve Analysis for Fine and Coarse Aggregates." Laboratory proficiency testing is a requirement in the Caltrans Independent Assurance (IA) Program and is mandated by Federal Highway Administration (FHWA).

The proficiency sample consisted of two varying samples. The samples were prepared in accordance to California Test 201. The target sample mass for the coarse aggregate gradation was 10,500 ± 125 grams with materials retained on the #4 sieve. The sample quantities used were sufficient to provide accurate results. The material used in the proficiency test originated from a single source. The intent of obtaining material from a single source is to minimize sample inconsistency. The aggregate material is prepared by a sieving and cleaning process removing deleterious materials that may negatively impact the test results.

The proficiency samples were prepared in the Caltrans Reference Sample Laboratory located at 6500 Folsom Blvd, Sacramento, CA. Each set of proficiency samples was designed with a baseline value determined prior to distribution.

California Test 202 determines the particle size distribution. Sieve analysis is an important step in developing HMA and PCC mix designs as it dictates the amount of the other elements to reach a certain target value of the mix.

The initial round of participating labs were 299 laboratories. The participants for this round of proficiency testing included private, local agencies, and state laboratories.

2.0 ANALYSIS OF TEST RESULTS

2.1 EVALUATION CRITERIA

Results were evaluated using a statistical evaluation system in which the mean (X) and standard deviation(s) were calculated for each test parameter. A rating score was then applied to the test results based on the criteria shown in Table 1. A test result with a score of 3 or greater was considered an acceptable result. A test result with a score of 2 or less was considered unacceptable and a retest was required.

Table 1: Evaluation Criteria

Test Result	Rating	Interpretation of Results	Acceptance
X ± 1.0s	5	Very Good	
X ± 1.5s	4	Good	Acceptable
X ± 2.0s	3	Fair	
X ± 2.5s	2	Poor	Unacceptable
X ± 3.0s	1	Very Poor	

2.2 INITIAL TEST

A total of 307 laboratories participated in the initial test. Laboratories were excluded from the statistical analysis for one of the following reasons: (1) Laboratories results were not submitted prescribed by the deadline or (2) Results were not submitted on the data sheet issued. Analysis for outliers in accordance with ASTM E 178 was conducted for the total 299 laboratories, and 33 outliers were found. This outliers are summarized in Table 2. The initial statistical analysis is summarized in Table 3.

Table 2: CT 202 Initial Test Results

		Initial Failures		
Sample	# of Labs	Failure Count (Lab ID)	Outlier Count (Lab ID)	Passing Labs
A	156	10, 75, 81, 89, 113, 122, 139, 146, 183, 191, 304, 322, 334, 372, 508, 531, 589 (17)	22, 29, 48, 49, 56, 57, 84, 170, 173, 182, 198, 211, 245, 250, 318, 340, 361, 419, 521, 524 (20)	119
C	143	40, 58, 65, 69, 140, 144, 164, 177, 193, 206, 271, 289, 293, 296, 308, 316, 341, 344, 353, 451, 480, 535, 562, 580, 586, 596, 609, 637,642, 655 (30)	30, 39, 59, 67, 120, 214, 264, 321, 329, 396, 479, 612, 616 (13)	100
Total	299	47	33	219

After excluding the outliers, the mean and standard deviation were recalculated to determine the score for each of the remaining 266 laboratories. The analysis results are presented in Table 3. Detailed test results are provided in Appendix A.

Table 3: California Test 202 Initial Statistical Analysis of Test Results

Sample	# of Laboratories	# of Outliers	# of Laboratories (used in analysis)	Number of Labs Achieved Score of				
				5	4	3	2	1
A	156	20	136	97	13	9	6	11
% of Total				71.3	9.6	6.6	4.4	8.1

Sample	# of Laboratories	# of Outliers	# of Laboratories (used in analysis)	Number of Labs Achieved Score of				
				5	4	3	2	1
C	143	13	130	53	38	11	10	18
% of Total				40.8	29.2	8.5	7.7	13.8

2.3   RETEST

Laboratories whose test results were considered as outliers and laboratories that scored below a rating of 3 were considered as unsatisfactory results. In the initial test, 80 laboratories did not receive an acceptable score. In July 2017, these laboratories were given the option to retest and were sent another sample. Out of the 80 laboratories 5 laboratories failed to submit retest results. The remaining 75 laboratories results are listed in Table 4. Their results were later scored and assigned a rating. The retest summary is presented in Table 5. Detailed test results and scores are provided in Appendix B. The following (20) laboratories 10, 22, 81, 84, 113, 164, 193, 198, 214, 245, 250, 321, 340, 341, 361, 396, 531, 589, 612, and 1712 failed the retest and were given the option for a third sample to test.

Table 4: Summary of Retest Results

California Test 202				
Sample	# of Labs	Retest Failures		Passing Labs
		Failure Count (Lab ID)	Outlier Count (Lab ID)	
B	75	10, 22, 81, 84, 113, 164, 193, 198, 214, 245, 250, 321, 340, 341, 361, 396, 531, 589, 612, 1712 (20)	113, 164, 194, 198, 214, 321, 612, 1712, (8)	55

Table 5: California Test 202 Retest Statistical Analysis of Test Results

Sample	# of Laboratories	# of Outliers	# of Laboratories (used in analysis)	Number of Labs Achieved Score of				
				5	4	3	2	1
B	75	8	67	23	20	12	2	10
% of Total				34.3	29.9	17.9	3.0	14.9

Table 5: Summary of Witness Test Results

Sample	# of Laboratories	# of Outliers	# of Laboratories (used in analysis)	Number of Labs Achieved Score of				
				5	4	3	2	1
B	20	0	8	0	4	4	0	0
% of Total				0	50	50	0	0

*12 Twelve laboratories were not included in the IA witness test results in table 5

2.4 COMBINED RESULTS

A total of 299 laboratories participated in the reference sample program, with 75 laboratories participating in both the initial test and the retest. The 12 laboratories that were not included in the I.A. witness summary were address independent of this report. Laboratories that failed to participate will remain on the inactive list until the laboratory meets the proficiency outlined in the Independent Assurance Manual for laboratory accreditation.

2.5   OBSERVATIONS

During the initial test there were 80 laboratories that failed the sieve analysis test. Consequently, retests were performed by these laboratories. Out of the 80 failed laboratories 5 laboratories failed to submit retest results. During the second round of testing 55 laboratories were able to produce acceptable results. These retest sample provided these 75 laboratories corrective measures to obtain acceptable results   The corrective measures included determining reasons for failures and providing help in resolving issues related to the equipment, test procedure and sample. The remaining 20 laboratories that failed to achieve acceptable results from the retest were provided a sample to perform a 3rd retest with Caltrans IA staff present. The following observations were made:

- Improper test procedure
- Sieves not calibrated

3.0   SUMMARY

In the initial round of testing, 299 laboratories participated in proficiency testing of coarse aggregate gradation using California Test 202. Out of the 299 participants, 80 laboratories failed in the initial test and 75 participated in the retest. The failures constitute laboratories whose results were considered as outliers and those with results below a score rating of 3. Laboratories that failed to submit their references sample results were not considered in the statistical analysis. Samples were provided to the 75 failed laboratories for a retest, and 55 laboratories passed with satisfactory results. The remaining 20 laboratory that failed the retest were given the option for a 3rd test with Caltrans IA staff present. Out of the 20 laboratories only 8 laboratories were included in witness summary report. A total of 282 laboratories achieved acceptable results for the proficient sample test.

4.0   REFERENCES

California Test Method 202, Method of Test for Sieve Analysis of Fine and Coarse Aggregates."

ASTM E178 – 80, "Standard Practice for Dealing with Outlying Observations,"

Caltrans, "Independent Assurance Manual," Sacramento, July 2005.

APPENDIX – A

Test Results from Initial Test

CT ID	Sample	#1	Score	#3/4	Score	#1/2	Score	#3/8	Score	#4	Score	#Pan	Score	Final Score
6	A	100%	5	91%	5	53%	5	81%	5	75%	5	0%	5	5
7	A	100%	5	90%	3	53%	5	79%	5	78%	4	0%	5	3
8	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
9	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
*10	A	100%	5	91%	5	49%	5	84%	1	76%	5	0%	5	1
12	A	100%	5	91%	5	52%	5	81%	5	76%	5	0%	5	5
15	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
16	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
17	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
*22	A	72%	1	91%	5	55%	5	79%	5	76%	5	0%	5	1
26	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
27	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
*29	A	100%	5	91%	5	33%	1	100%	1	76%	5	0%	5	1
31	A	100%	5	91%	5	54%	5	80%	5	76%	5	0%	5	5
32	A	100%	5	90%	3	55%	5	80%	5	76%	5	0%	5	3
*48	A	100%	5	92%	5	33%	1	99%	1	76%	5	0%	5	1
*49	A	100%	5	95%	1	52%	5	78%	5	76%	5	0%	5	1
50	A	100%	5	90%	4	53%	5	80%	5	76%	5	0%	5	4
52	A	100%	5	91%	5	54%	5	79%	5	77%	5	0%	5	5
*56	A	100%	5	91%	5	33%	1	100%	1	77%	5	0%	5	1
*57	A	100%	5	93%	2	34%	1	97%	1	76%	5	0%	5	1
62	A	100%	5	91%	5	53%	5	79%	5	76%	5	0%	5	5
63	A	100%	5	91%	5	53%	5	79%	5	77%	5	0%	5	5
68	A	100%	5	91%	5	54%	5	79%	5	77%	5	0%	5	5
70	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
73	A	100%	5	92%	5	53%	5	80%	5	76%	5	0%	5	5
74	A	100%	5	91%	5	54%	5	79%	5	77%	5	0%	5	5
*75	A	100%	5	93%	2	50%	5	78%	5	79%	3	0%	5	2
76	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
79	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
*81	A	91%	1	90%	4	54%	5	81%	5	75%	5	0%	5	1
83	A	100%	5	92%	3	53%	5	79%	5	76%	5	0%	5	3
*84	A	100%	5	94%	1	66%	2	78%	5	62%	1	0%	5	1
86	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
87	A	100%	5	91%	5	55%	5	79%	5	76%	5	0%	5	5
*89	A	100%	5	92%	5	56%	5	85%	1	79%	4	0%	5	1
94	A	100%	5	91%	5	53%	5	79%	5	76%	5	0%	5	5
97	A	100%	5	92%	5	54%	5	78%	5	76%	5	0%	5	5

CT ID	Sample	#1	Score	#3/4	Score	#1/2	Score	#3/8	Score	#4	Score	#Pan	Score	Final Score
99	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
100	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
*113	A	100%	5	93%	2	57%	5	76%	2	76%	5	1%	5	2
114	A	100%	5	91%	5	54%	5	78%	5	76%	5	0%	5	5
*122	A	100%	5	90%	2	54%	5	78%	5	79%	3	0%	5	2
123	A	100%	5	90%	3	54%	5	78%	5	79%	4	0%	5	3
125	A	100%	5	91%	5	53%	5	79%	5	76%	5	0%	5	5
135	A	100%	5	91%	5	55%	5	78%	5	76%	5	0%	5	5
137	A	100%	5	92%	5	53%	5	79%	5	76%	5	0%	5	5
*139	A	100%	5	93%	1	53%	5	78%	5	76%	5	0%	5	1
*146	A	100%	5	91%	5	46%	4	87%	1	76%	5	0%	5	1
154	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
158	A	100%	5	91%	5	53%	5	79%	5	76%	5	0%	5	5
160	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
169	A	100%	5	91%	5	54%	5	79%	5	76%	5	1%	5	5
*170	A	100%	5	91%	5	45%	4	24%	1	0%	1	0%	5	1
*173	A	100%	5	91%	5	33%	1	100%	1	76%	5	0%	5	1
*182	A	100%	5	92%	3	32%	1	100%	1	76%	5	0%	5	1
*183	A	100%	5	93%	2	50%	5	79%	5	78%	4	0%	5	2
*191	A	100%	5	90%	2	53%	5	78%	5	78%	5	10%	1	1
192	A	100%	5	91%	5	53%	5	79%	5	76%	5	0%	5	5
*198	A	79%	1	92%	5	54%	5	79%	5	76%	5	0%	5	1
203	A	100%	5	91%	5	53%	5	79%	5	76%	5	0%	5	5
208	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
*211	A	100%	5	96%	1	77%	1	67%	1	57%	1	43%	1	1
227	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
234	A	100%	5	93%	3	51%	5	80%	5	76%	5	0%	5	3
237	A	100%	5	92%	4	51%	5	79%	5	78%	4	0%	5	4
238	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
*245	A	100%	5	95%	1	52%	5	78%	5	76%	5	0%	5	1
246	A	100%	5	91%	5	54%	5	80%	5	76%	5	0%	5	5
249	A	100%	5	91%	5	53%	5	80%	5	77%	5	0%	5	5
*250	A	100%	5	92%	5	33%	1	99%	1	76%	5	0%	5	1
252	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
253	A	100%	5	91%	5	55%	5	77%	4	77%	5	0%	5	4
257	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
263	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
268	A	100%	5	91%	5	52%	5	81%	4	76%	5	0%	5	4
269	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
271	A	100%	5	92%	3	51%	5	79%	5	78%	4	0%	5	3
282	A	100%	5	92%	5	54%	5	79%	5	76%	5	0%	5	5
283	A	100%	5	91%	5	54%	5	80%	5	76%	5	0%	5	5

CT ID	Sample	#1	Score	#3/4	Score	#1/2	Score	#3/8	Score	#4	Score	#Pan	Score	Final Score
285	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
302	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
*304	A	100%	5	93%	1	51%	5	80%	5	76%	5	0%	5	1
309	A	100%	5	91%	5	54%	5	80%	5	76%	5	0%	5	5
*318	A	80%	1	93%	2	52%	5	80%	5	76%	5	0%	5	1
322	A	100%	5	89%	2	55%	5	79%	5	76%	5	0%	5	2
330	A	100%	5	92%	4	52%	5	79%	5	76%	5	0%	5	4
332	A	100%	5	92%	5	53%	5	80%	5	76%	5	0%	5	5
*334	A	100%	5	93%	1	51%	5	80%	5	76%	5	0%	5	1
337	A	100%	5	91%	5	52%	5	81%	5	76%	5	0%	5	5
*340	A	100%	5	94%	1	51%	5	78%	5	77%	5	0%	5	1
342	A	100%	5	91%	5	53%	5	79%	5	76%	5	0%	5	5
354	A	100%	5	92%	5	54%	5	78%	5	76%	5	0%	5	5
356	A	100%	5	91%	5	54%	5	80%	5	76%	5	0%	5	5
359	A	100%	5	90%	4	53%	5	79%	5	78%	4	0%	5	4
*361	A	85%	1	94%	1	52%	5	80%	5	75%	5	0%	5	1
366	A	100%	5	91%	5	53%	5	79%	5	76%	5	0%	5	5
367	A	100%	5	91%	5	54%	5	80%	5	76%	5	0%	5	5
*372	A	100%	5	94%	1	51%	5	79%	5	76%	5	0%	5	1
377	A	100%	5	91%	5	53%	5	79%	5	76%	5	0%	5	5
381	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
382	A	100%	5	92%	5	52%	5	79%	5	78%	4	0%	5	4
387	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
388	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
389	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
401	A	100%	5	91%	5	53%	5	79%	5	76%	5	0%	5	5
402	A	100%	5	92%	5	53%	5	80%	5	76%	5	0%	5	5
403	A	100%	5	90%	4	54%	5	80%	5	76%	5	0%	5	4
407	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
412	A	100%	5	91%	5	55%	5	78%	5	76%	5	0%	5	5
413	A	100%	5	91%	5	54%	5	80%	5	76%	5	0%	5	5
417	A	100%	5	92%	5	53%	5	80%	5	76%	5	0%	5	5
418	A	100%	5	91%	5	52%	5	81%	5	76%	5	0%	5	5
*419	A	79%	1	93%	3	52%	5	80%	5	76%	5	0%	5	1
423	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
426	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
434	A	100%	5	91%	5	53%	5	79%	5	76%	5	0%	5	5
447	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
449	A	100%	5	90%	4	52%	5	80%	5	77%	5	0%	5	4
454	A	100%	5	91%	5	53%	5	79%	5	76%	5	0%	5	5
457	A	100%	5	91%	5	52%	5	80%	5	77%	5	0%	5	5
458	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5

CT ID	Sample	#1	Score	#3/4	Score	#1/2	Score	#3/8	Score	#4	Score	#Pan	Score	Final Score
461	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
464	A	100%	5	91%	5	55%	5	78%	5	76%	5	0%	5	5
469	A	100%	5	91%	5	55%	5	79%	5	76%	5	0%	5	5
476	A	100%	5	91%	5	54%	5	80%	5	76%	5	0%	5	5
478	A	100%	5	91%	5	55%	5	79%	5	76%	5	0%	5	5
482	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
483	A	100%	5	92%	5	53%	5	79%	5	76%	5	0%	5	5
485	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
493	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
504	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
*508	A	100%	5	90%	4	56%	5	76%	2	78%	4	1%	5	2
509	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
513	A	100%	5	91%	5	52%	5	79%	5	78%	5	1%	5	5
*521	A	100%	5	96%	1	72%	1	61%	1	50%	1	50%	1	1
522	A	100%	5	92%	5	53%	5	80%	5	76%	5	0%	5	5
*524	A	100%	5	91%	5	33%	1	100%	1	76%	5	0%	5	1
*531	A	100%	5	92%	5	46%	4	87%	1	76%	5	0%	5	1
534	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
541	A	100%	5	90%	3	55%	5	79%	5	76%	5	0%	5	3
552	A	100%	5	91%	5	52%	5	79%	5	79%	4	1%	5	4
565	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
574	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
584	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
*589	A	100%	5	92%	5	54%	5	76%	3	80%	2	3%	1	1
593	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
600	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
608	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
614	A	100%	5	91%	5	53%	5	80%	5	76%	5	0%	5	5
628	A	100%	5	91%	5	54%	5	79%	5	76%	5	0%	5	5
635	A	100%	5	90%	4	53%	5	78%	5	78%	4	0%	5	4
645	A	100%	5	92%	5	52%	5	81%	5	76%	5	0%	5	5
654	A	100%	5	90%	4	53%	5	81%	4	75%	5	0%	5	4
1703	A	100%	5	91%	5	53%	5	79%	5	76%	5	0%	5	5
1706	A	100%	5	91%	5	53%	5	82%	3	74%	4	0%	5	3

Legend:

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Unacceptable Score

CT ID	Sample	#1	Score	#3/4	Score	#1/2	Score	#3/8	Score	#4	Score	#Pan	Score	Final Score
23	C	100%	5	90%	5	53%	5	78%	5	79%	5	0%	5	5
24	C	100%	5	92%	3	51%	3	79%	5	79%	5	1%	5	3
*30	C	100%	5	90%	5	53%	5	79%	5	78%	5	1%	5	5
*39	C	100%	5	97%	1	52%	5	79%	5	78%	5	0%	5	1
40	C	100%	5	92%	4	53%	5	79%	5	78%	5	1%	5	4
43	C	100%	5	91%	5	52%	5	79%	5	79%	5	0%	5	5
47	C	100%	5	90%	5	53%	5	79%	5	79%	5	1%	5	5
53	C	100%	5	90%	5	54%	5	79%	5	78%	5	1%	5	5
55	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
58	C	100%	5	91%	5	55%	2	77%	1	78%	5	0%	5	1
*59	C	100%	5	99%	1	55%	3	69%	1	78%	5	1%	5	1
64	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
65	C	100%	5	90%	5	53%	5	79%	5	79%	4	1%	5	4
66	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
*67	C	100%	5	90%	5	53%	5	79%	5	79%	5	1%	5	5
*69	C	100%	5	91%	5	56%	1	75%	1	78%	5	1%	5	1
71	C	100%	5	90%	5	53%	5	80%	4	78%	5	1%	5	4
80	C	100%	5	91%	5	52%	5	79%	5	78%	5	0%	5	5
88	C	100%	5	90%	5	53%	5	79%	5	79%	4	1%	5	4
90	C	100%	5	90%	5	54%	5	79%	5	78%	5	0%	5	5
92	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
93	C	100%	5	90%	5	52%	5	80%	3	78%	5	1%	5	3
96	C	100%	5	90%	4	54%	5	78%	5	79%	5	0%	5	4
98	C	100%	5	91%	5	53%	5	78%	4	78%	5	0%	5	4
103	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
104	C	100%	5	91%	5	53%	5	79%	5	78%	5	0%	5	5
118	C	100%	5	91%	5	53%	5	79%	5	78%	5	0%	5	5
*120	C	100%	5	91%	5	54%	5	79%	5	79%	3	1%	4	3
128	C	100%	5	90%	5	54%	4	78%	4	78%	5	1%	5	4
131	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
132	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
*140	C	100%	5	90%	5	55%	1	79%	5	79%	5	0%	5	1
143	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
*144	C	100%	5	91%	5	54%	3	77%	1	78%	5	1%	5	1
145	C	100%	5	90%	5	54%	4	79%	5	77%	4	0%	5	4
147	C	100%	5	90%	5	53%	5	78%	5	79%	4	0%	5	4
156	C	100%	5	92%	4	53%	5	78%	4	78%	5	0%	5	4
161	C	100%	5	91%	5	53%	5	78%	3	78%	5	0%	5	3
*164	C	100%	5	92%	3	51%	2	79%	5	79%	5	0%	5	2
166	C	100%	5	91%	5	52%	5	79%	5	78%	5	0%	5	5
*177	C	100%	5	90%	5	54%	4	79%	5	76%	1	0%	5	1

CT ID	Sample	#1	Score	#3/4	Score	#1/2	Score	#3/8	Score	#4	Score	#Pan	Score	Final Score
184	C	100%	5	90%	4	53%	5	79%	5	78%	5	0%	5	4
*193	C	100%	5	92%	2	52%	5	78%	3	78%	5	0%	5	2
195	C	100%	5	90%	5	54%	5	78%	5	78%	5	0%	5	5
196	C	100%	5	91%	5	53%	5	79%	5	78%	5	0%	5	5
197	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
205	C	100%	5	91%	5	53%	5	78%	5	78%	5	0%	5	5
*206	C	100%	5	91%	5	53%	5	79%	5	76%	1	0%	5	1
209	C	100%	5	91%	5	53%	5	79%	5	78%	5	0%	5	5
210	C	100%	5	91%	5	52%	5	79%	5	78%	5	0%	5	5
213	C	100%	5	91%	5	52%	4	79%	5	79%	5	0%	5	4
***214**	C	39%	1	90%	5	54%	4	78%	4	79%	5	0%	5	1
218	C	100%	5	90%	5	53%	5	79%	5	79%	5	0%	5	5
219	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
221	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
226	C	100%	5	90%	5	54%	5	78%	5	79%	5	0%	5	5
228	C	100%	5	91%	5	54%	5	78%	3	78%	5	0%	5	3
241	C	100%	5	90%	5	54%	5	78%	5	78%	5	0%	5	5
248	C	100%	5	91%	5	53%	5	79%	5	79%	5	0%	5	5
255	C	100%	5	91%	5	52%	4	80%	4	78%	5	0%	5	4
***264**	C	100%	5	91%	5	53%	5	79%	5	79%	5	1%	5	5
265	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
266	C	100%	5	90%	5	53%	5	78%	5	79%	5	0%	5	5
*271	C	100%	5	92%	2	51%	2	79%	5	78%	5	0%	5	2
272	C	100%	5	90%	5	53%	5	80%	4	78%	5	0%	5	4
284	C	100%	5	90%	5	54%	5	78%	5	78%	5	0%	5	5
*289	C	91%	1	90%	5	53%	5	79%	5	78%	5	0%	5	1
290	C	100%	5	91%	5	54%	5	78%	5	78%	5	1%	5	5
*293	C	100%	5	92%	3	50%	1	80%	4	78%	5	0%	5	1
*296	C	83%	1	90%	5	53%	5	79%	5	79%	5	1%	5	1
301	C	100%	5	90%	5	54%	4	78%	3	78%	5	0%	5	3
303	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
*308	C	100%	5	92%	4	53%	5	79%	5	76%	1	0%	5	1
310	C	100%	5	91%	5	52%	4	79%	5	78%	5	0%	5	4
311	C	100%	5	91%	5	53%	5	78%	4	78%	5	0%	5	4
*316	C	100%	5	91%	5	53%	5	79%	5	79%	4	1%	4	4
***321**	C	100%	5	84%	1	52%	4	81%	1	83%	1	0%	5	1
***329**	C	50%	1	92%	3	49%	1	81%	1	79%	5	0%	5	1
331	C	100%	5	90%	5	54%	4	78%	5	78%	5	0%	5	4
333	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
338	C	100%	5	91%	5	53%	5	79%	5	78%	5	0%	5	5
339	C	100%	5	91%	5	52%	5	79%	5	78%	5	0%	5	5
*341	C	100%	5	92%	4	53%	5	80%	4	76%	1	0%	5	1

CT ID	Sample	#1	Score	#3/4	Score	#1/2	Score	#3/8	Score	#4	Score	#Pan	Score	Final Score
*344	C	100%	5	90%	5	54%	3	77%	2	79%	5	0%	5	2
346	C	100%	5	90%	4	53%	5	79%	5	79%	5	0%	5	4
347	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
348	C	100%	5	91%	5	53%	5	79%	5	78%	5	0%	5	5
349	C	100%	5	91%	5	53%	5	79%	5	78%	5	0%	5	5
*353	C	100%	5	93%	1	51%	2	78%	5	78%	5	0%	5	1
360	C	100%	5	92%	4	51%	3	79%	5	78%	5	0%	5	3
364	C	100%	5	90%	5	53%	5	79%	5	79%	5	1%	5	5
369	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
385	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
393	C	100%	5	90%	5	54%	4	77%	3	79%	4	1%	5	3
394	C	100%	5	91%	5	53%	5	79%	5	78%	5	0%	5	5
*396	C	100%	5	92%	2	54%	4	58%	1	96%	1	0%	5	1
420	C	100%	5	90%	5	53%	5	78%	5	79%	4	1%	5	4
422	C	100%	5	92%	4	52%	4	79%	5	78%	5	1%	5	4
428	C	100%	5	90%	5	53%	5	78%	5	79%	5	0%	5	5
430	C	100%	5	90%	5	53%	5	79%	5	79%	5	1%	5	5
432	C	100%	5	90%	5	53%	5	79%	5	79%	5	1%	5	5
438	C	100%	5	91%	5	53%	5	79%	5	78%	5	0%	5	5
441	C	100%	5	90%	5	53%	5	79%	5	79%	5	0%	5	5
442	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
*451	C	100%	5	90%	4	54%	5	79%	5	78%	5	0%	5	4
455	C	100%	5	90%	4	53%	5	79%	5	79%	5	0%	5	4
*479	C	100%	5	94%	1	50%	1	79%	5	77%	2	0%	5	1
*480	C	100%	5	91%	5	54%	5	79%	5	76%	1	0%	5	1
495	C	100%	5	90%	4	53%	5	79%	5	78%	5	0%	5	4
511	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
520	C	100%	5	91%	5	52%	4	79%	5	78%	5	0%	5	4
527	C	100%	5	90%	5	52%	5	79%	5	79%	5	0%	5	5
533	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
*535	C	100%	5	91%	5	54%	5	80%	4	76%	1	0%	5	1
536	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
538	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
540	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
543	C	100%	5	90%	5	53%	5	79%	5	78%	5	1%	5	5
550	C	100%	5	89%	4	54%	5	79%	5	79%	5	0%	5	4
551	C	100%	5	91%	5	53%	5	79%	5	78%	5	1%	5	5
*562	C	100%	5	89%	2	54%	3	79%	5	78%	5	0%	5	2
569	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
*580	C	100%	5	91%	5	53%	5	79%	5	78%	5	0%	5	5
*586	C	100%	5	93%	1	51%	3	80%	4	76%	1	0%	5	1
590	C	100%	5	91%	5	52%	5	79%	5	78%	5	0%	5	5

CT ID	Sample	#1	Score	#3/4	Score	#1/2	Score	#3/8	Score	#4	Score	#Pan	Score	Final Score
595	C	100%	5	90%	5	54%	4	79%	5	77%	4	0%	5	4
*596	C	100%	5	92%	2	51%	2	80%	4	78%	5	0%	5	2
607	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
*609	C	100%	5	91%	5	53%	5	79%	5	78%	5	0%	5	5
*612	C	72%	1	94%	1	41%	1	88%	1	78%	5	0%	5	1
615	C	100%	5	91%	5	53%	5	78%	5	78%	5	1%	5	5
*616	C	36%	1	90%	5	52%	5	80%	4	78%	5	0%	5	1
627	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
634	C	100%	5	91%	5	52%	4	79%	5	79%	5	0%	5	4
636	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
*637	C	100%	5	88%	1	54%	3	78%	3	80%	1	0%	5	1
*642	C	100%	5	91%	5	55%	2	79%	5	75%	1	0%	5	1
643	C	100%	5	90%	5	52%	5	79%	5	78%	5	0%	5	5
644	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5
649	C	100%	5	91%	5	52%	5	79%	5	78%	5	0%	5	5
652	C	100%	5	90%	5	54%	4	79%	5	78%	5	0%	5	4
*655	C	100%	5	91%	4	53%	5	80%	4	76%	1	0%	5	1
1704	C	100%	5	90%	5	53%	5	79%	5	78%	5	0%	5	5

Legend:

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Unacceptable Score

Appendix B Results from Retest

CT ID	Sample	#1	Score	#3/4	Score	#1/2	Score	#3/8	Score	#4	Score	#Pan	Score	Final Score
10	B	100%	5	89%	5	51%	5	77%	5	83%	5	0.33	2	2
22	B	100%	5	89%	5	51%	5	77%	5	83%	5	0.26%	4	4
29	B	100%	5	89%	5	52%	4	76%	5	83%	5	0.08%	5	4
30	B	100%	1	89%	5	51%	5	77%	5	83%	5	0.23%	4	1
39	B	100%	1	89%	5	50%	5	77%	5	83%	5	0.05%	4	4
40	B	100%	5	90%	5	51%	5	76%	5	83%	5	0.14%	5	5
48	B	100%	5	89%	5	52%	5	77%	5	83%	5	0.18%	5	5
49	B	100%	5	92%	3	49%	4	77%	5	83%	5	0.21%	5	3
56	B	100%	5	89%	4	51%	5	77%	5	83%	5	0.08%	5	4
57	B	100%	5	91%	4	51%	5	75%	4	83%	5	0.14%	5	4

CT ID	Sample	#1	Score	#3/4	Score	#1/2	Score	#3/8	Score	#4	Score	#Pan	Score	Final Score
58	B	100%	5	89%	5	52%	5	76%	5	83%	5	0.15%	5	5
59	B	100%	5	89%	5	52%	5	76%	5	83%	5	0.27%	3	3
65	B	100%	5	89%	5	51%	5	77%	5	83%	5	0.18%	5	5
67	B	100%	5	89%	5	51%	5	77%	5	83%	5	0.11%	5	5
69	B	100%	5	88%	4	53%	4	76%	5	83%	5	0.13%	5	4
75	B	100%	5	90%	5	50%	5	77%	5	83%	5	0.14%	5	5
*81	B	100%	1	89%	5	51%	5	77%	5	83%	5	0.10%	5	1
*84	B	100%	5	91%	5	49%	4	79%	2	81%	1	0.08%	5	1
*113	B	100%	1	90%	5	53%	4	95%	1	62%	1	0.09%	5	1
120	B	100%	5	89%	5	52%	5	76%	5	83%	5	0.26%	4	4
122	B	100%	5	89%	5	50%	5	77%	5	83%	5	0.23%	4	4
139	B	100%	5	91%	5	52%	5	75%	3	83%	5	0.17%	5	3
140	B	100%	5	90%	5	50%	5	78%	5	83%	5	0.12%	5	5
144	B	100%	5	90%	5	50%	5	77%	5	83%	5	0.12%	5	5
146	B	100%	5	90%	5	50%	5	77%	5	83%	5	0.12%	5	5
*164	B	100%	5	89%	5	51%	5	76%	5	83%	5	0.50%	1	1
170	B	100%	5	89%	5	51%	5	77%	5	83%	5	0.20%	5	5
173	B	100%	5	89%	5	51%	5	77%	5	83%	5	0.25%	4	4
177	B	100%	5	91%	4	49%	4	77%	5	83%	5	0.16%	5	4
182	B	100%	5	88%	4	50%	5	78%	3	83%	5	0.06%	4	3
183	B	100%	5	91%	4	50%	5	76%	5	83%	5	0.14%	5	4
191	B	100%	5	89%	5	51%	5	77%	5	83%	5	0.09%	5	5
*193	B	100%	5	89%	5	53%	4	75%	4	83%	5	0.64%	1	1
*198	B	100%	5	94%	1	74%	1	89%	1	93%	1	0.09%	5	1
*214	B	99%	1	89%	4	51%	5	78%	5	83%	5	0.07%	5	1
*245	B	100%	5	94%	1	49%	5	75%	3	83%	5	0.30%	3	1
*250	B	100%	1	90%	5	54%	3	74%	1	83%	5	0.17%	5	1
264	B	100%	5	91%	5	49%	5	77%	5	83%	5	0.15%	5	5
289	B	100%	5	90%	5	52%	5	75%	4	83%	5	0.06%	4	4
293	B	100%	5	90%	5	50%	5	77%	5	83%	5	0.27%	3	3
296	B	100%	5	89%	5	53%	4	75%	4	82%	3	0.08%	5	3
308	B	100%	5	90%	5	50%	5	77%	5	83%	5	0.12%	5	5
316	B	100%	5	90%	5	52%	5	76%	5	83%	5	0.23%	4	4
318	B	100%	5	92%	3	49%	5	77%	5	83%	5	0.15%	5	3
321	B	100%	5	89%	5	50%	5	78%	4	84%	3	0.05%	4	3
322	B	100%	5	89%	5	51%	5	77%	5	83%	5	0.19%	5	5

CT ID	Sample	#1	Score	#3/4	Score	#1/2	Score	#3/8	Score	#4	Score	#Pan	Score	Final Score
329	B	100%	5	89%	5	51%	5	77%	5	83%	4	0.05%	4	4
334	B	100%	5	90%	5	51%	5	77%	5	83%	5	0.16%	5	5
*340	B	100%	5	90%	5	50%	5	77%	5	83%	5	0.38%	1	1
*341	B	100%	5	90%	5	51%	5	78%	4	82%	2	0.30%	3	2
344	B	100%	5	89%	5	52%	5	76%	5	83%	5	0.13%	5	5
353	B	100%	5	89%	5	52%	5	76%	5	83%	5	0.03%	3	3
*361	B	100%	5	92%	2	49%	4	78%	5	82%	2	0.32%	2	2
372	B	100%	5	90%	5	50%	5	77%	5	83%	5	0.22%	5	5
*396	B	100%	5	90%	5	55%	2	73%	1	83%	5	0.11%	5	1
419	B	100%	5	91%	5	49%	4	77%	5	83%	5	0.08%	5	4
451	B	100%	5	88%	4	52%	5	77%	5	83%	5	0.14%	5	4
479	B	100%	5	90%	5	50%	5	77%	5	83%	5	0.14%	5	5
480	B	100%	5	89%	5	51%	5	76%	5	84%	3	0.14%	5	3
508	B	100%	5	90%	5	51%	5	76%	5	83%	5	0.12%	5	5
521	B	100%	5	90%	5	51%	5	77%	5	83%	5	0.20%	5	5
524	B	100%	5	89%	5	51%	5	77%	5	83%	5	0.12%	5	5
*531	B	100%	5	90%	5	50%	5	77%	5	85%	1	0.00%	3	1
562	B	100%	5	90%	5	50%	5	78%	4	82%	3	0.10%	5	3
580	B	100%	5	90%	5	50%	5	77%	5	83%	5	0.10%	5	5
586	B	100%	5	91%	4	50%	5	75%	4	83%	5	0.12%	5	4
*589	B	100%	5	90%	5	55%	1	73%	1	83%	5	0.10%	5	1
596	B	100%	5	92%	3	48%	3	78%	5	83%	5	0.16%	5	3
609	B	100%	5	90%	5	50%	5	78%	5	83%	4	0.15%	5	4
*612	B	100%	5	99%	1	43%	1	75%	4	83%	5	0.13%	5	1
616	B	100%	5	89%	4	50%	5	78%	4	83%	5	0.08%	5	4
637	B	100%	5	90%	5	51%	5	77%	5	83%	5	0.07%	4	4
642	B	100%	5	90%	5	50%	5	78%	5	83%	4	0.06%	4	4
655	B	100%	5	89%	5	51%	5	77%	5	83%	5	0.28%	3	3
*1712	B	99%	1	88%	3	53%	4	77%	5	83%	5	0.08%	5	1

Legend:

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Unacceptable Score

Appendix C Witness Test Results

CT ID	Sample	#1	Score	#3/4	Score	#1/2	Score	#3/8	Score	#4	Score	#Pan	Score	Final Score
10	B	100%	5	89%	5	52%	5	78%	5	83%	5	0.27%	3	3
81	B	100%	5	89%	5	52%	5	77%	5	84%	4	0.0%	5	4
164	B	100%	5	88%	3	53%	5	77%	5	84%	5	0.19%	4	3
193	B	100%	5	92%	4	50%	4	78%	5	83%	5	0.0%	5	4
214	B	100%	5	89%	5	51%	5	78%	5	84%	5	0.0%	4	4
250	B	99.8%	3	90%	5	51%	5	78%	5	83%	5	0.0%	5	3
341	B	100%	5	91%	5	54%	3	80%	3	77%	3	0.0%	5	3
612	B	100%	5	92%	4	51%	5	76%	5	83%	5	0.0%	5	4